



US00637655B1

(12) **United States Patent**  
Berg et al.

(10) **Patent No.:** US 6,376,655 B1  
(45) **Date of Patent:** Apr. 23, 2002

## (54) PHYSICALLY FUNCTIONAL MATERIALS

(75) Inventors: Rolf Henrik Berg, Rungsted Kyst; Søren Hvilsted, Hørsholm; P. S. Ramanujam, Roskilde, all of (DK)

(73) Assignee: Risø National Laboratory, Roskilde (DK)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: 08/973,179

(22) PCT Filed: Jun. 3, 1996

(86) PCT No.: PCT/DK96/00237

§ 371 Date: Dec. 2, 1997

§ 102(e) Date: Dec. 2, 1997

(87) PCT Pub. No.: WO96/38410

PCT Pub. Date: Dec. 5, 1996

## (30) Foreign Application Priority Data

Jun. 2, 1995 (DK) ..... 0628/95

(51) Int. Cl.<sup>7</sup> ..... C07C 245/08; C07C 255/65; G11B 7/24

(52) U.S. Cl. ..... 534/573; 534/829; 534/854; 534/DIG. 3; 524/190; 527/207; 430/1; 430/2

(58) Field of Search ..... 534/573, DIG. 3, 534/854, 829; 524/190; 527/207; 430/1, 2

## (56) References Cited

## U.S. PATENT DOCUMENTS

4,619,990 A	*	10/1986	Elmasry	.....	534/573
5,019,476 A	*	5/1991	Kanno et al.	.....	430/20
5,275,924 A	*	1/1994	Devonald et al.	.....	430/495
5,496,670 A	*	3/1996	Hvilsted et al.	.....	430/56
5,525,265 A	*	6/1996	Wit et al.	.....	252/587

## FOREIGN PATENT DOCUMENTS

DE	19500228	7/1995
EP	0369432	5/1990
EP	0474431	3/1992
EP	0550105	7/1993
EP	0597826	5/1994
EP	0615234	9/1994
GB	2201155	8/1988
WO	8605505	9/1986

## OTHER PUBLICATIONS

Natansohn, et al., Azo Polymers for Reversible Optical Storage. 4. Cooperative Motion of Rigid Groups in Semicrystalline Polymers, *Macromolecules*, vol. 27, No. 9, pp. 2580–2585, 1994.

\* cited by examiner

Primary Examiner—Fiona T. Powers

(74) Attorney, Agent, or Firm—Iver P. Cooper

## (57) ABSTRACT

The invention relates to novel monodisperse or polydisperse compounds, in general named DNO (diamino acid Nα-substituted oligopeptides), preferably low molecular weight polypeptides, e.g., based on ornithine, lysine, diaminobutyric acid, diaminopropionic acid, aminoethylglycine or other amino acids or peptides having azobenzenes or other physically functional groups, e.g., photoresponsive groups, as side chains. These compounds may be synthesized using solid phase peptide synthesis techniques. Materials, e.g., thin films, comprising such compounds may be used for optical storage of information (holographic data storage), nonlinear optics (NLO), as photoconductors, photonic band-gap materials, electrically conducting materials, electroluminescent materials, piezo-electric materials, pyroelectric materials, magnetic materials, ferromagnetic materials, ferroelectric materials, photorefractive materials, or materials in which light-induced conformational changes can be produced. Optical anisotropy may reversibly be generated with polarized laser light whereby a hologram is formed. First order diffraction efficiencies of up to around 80% have been obtained.



US005496670A

**United States Patent [19]**  
**Hvilsted et al.**

[11] **Patent Number:** **5,496,670**  
[45] **Date of Patent:** **Mar. 5, 1996**

**[54] OPTICAL STORAGE MEDIUM**

[75] Inventors: **Søren Hvilsted**, Hørsholm; **P. S. Ramanujam**, Roskilde, both of Denmark; **Fulvio Andruzzi**, Pisa, Italy

[73] Assignees: **Risø National Laboratory**, Roskilde, Denmark; **Consiglio Nazionale della Ricerca**, Rome, Italy

[21] Appl. No.: **113,303**

[22] Filed: **Aug. 30, 1993**

[51] Int. Cl.<sup>6</sup> ..... **G03G 15/00**

[52] U.S. Cl. ..... **430/56; 528/185; 528/210; 528/272; 528/288; 528/289; 528/291; 430/20; 430/322; 430/363; 430/945**

[58] Field of Search ..... **528/272, 288, 528/289, 291, 185, 210; 430/20, 56, 322, 363, 945**

**[56] References Cited**

**PUBLICATIONS**

Eich et al., J. Opt. Soc. Am. B/vol. 7, No. 8, pp. 1428-1436 (Aug. 1990).

Gibbons et al., Nature, vol. 351, pp. 49-50 (May 2, 1991).

Chen et al., Optics Letters, vol. 17, No. 6, pp. 441-443 (Mar. 15, 1992).

Rochon et al., Appl. Phys. Lett. 60, (1) pp. 4-5 (1992).

Natansohn et al., Macromolecules 25, 2268-2273 (1992).

Natansohn et al., Macromolecules 25, 5531-5532 (1992).

Xie et al., Chem. Mater. 5, 403-411 (1993).

Primary Examiner—Samuel A. Acquah  
Attorney, Agent, or Firm—Birch, Stewart, Kolasch & Birch

**[57] ABSTRACT**

A macroscopically isotropic side chain liquid crystal polymer is described containing photochromic mesogenic groups and which through irradiation with light is capable of being permanently or substantially permanently converted into an optically anisotropic phase without having bccn pre-oriented. The polymer is preferably a polyester between on the one hand either an aliphatic, optionally substituted,  $\alpha,\omega$ -dicarboxylic acid having a total chain length of up to 24 carbon atoms, or an aryl-, in particular phenyl-, carboxylic acid, and on the other hand an optionally substituted 1,3-propanediol containing the mesogenic group, or a group containing the mesogenic group, attached to the carbon in the 2-position. Furthermore, an optical storage device comprising a film of the polymer.

**43 Claims, 5 Drawing Sheets**

